ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

M. Tech.
POWER ELECTRONICS

(Applicable for the batches admitted from 2015-2016)

VALLURUPALLI NAGESWARA RAO VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

An Autonomous Institute, Accredited by NAAC with 'A' Grade
NBA Accreditation for CE, EEE, ME, ECE, CSE, EIE, IT B.Tech. Programmes
Approved by AICTE, New Delhi, Affiliated to JNTUH
Recognized as "College with Potential for Excellence" by UGC
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VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
HYDERABAD
An Autonomous Institute

Academic Regulations - M.Tech. Programme
(Applicable for the batches admitted from the academic year 2015-2016)

1. Introduction

Academic programmes of the institute are governed by rules and regulations as approved by the Academic Council of the institute.

These academic rules and regulations are effective from the academic year 2015-16, for the students admitted into two year post graduate programme offered by the college leading to Master of Technology (M. Tech.) degree in different specializations offered by the departments of Civil Engineering, Electrical and Electronics Engineering, Mechanical Engineering, Electronics and Communication Engineering, Computer Science and Engineering, Information Technology and Electronics and Instrumentation Engineering.

The M.Tech. degree of Jawaharlal Nehru Technological University Hyderabad shall be conferred on students who are admitted to the programme after fulfilling all the requirements for the award of the degree.

1.1 Eligibility for Admissions

Admission to the above program shall be made subject to the eligibility and qualifications prescribed from time to time. Admissions shall be made on the basis of GATE Rank and merit rank obtained at an Entrance Test conducted by the TSSCHE or as decided by TSSCHE subject to reservations prescribed by the university/ State Government from time to time.

2. Programmes of study

The following two year M.Tech. degree programmes of study are offered by the departments at VNR VJIET.

Department	Specializations
ME	1. Advanced Manufacturing Systems 2. Automation 3. CAD/CAM
CE	1. Highway Engineering 2. Structural Engineering 3 Geotechnical Engineering
EEE	1. Power Electronics 2. Power Systems
CSE	1. Software Engineering 2. Computer Science and Engineering
ECE	1. VLSI System Design 2. Embedded Systems
EIE	Electronics and Instrumentation
IT	Computer Networks and Information Security

- **'ENGLISH'** language is used as the medium of instruction in all the above programmes.

3. Attendance requirements

Each academic year shall be divided into two semesters, each of 90 Instructions days, excluding examination, evaluation, declaration of results etc.

3.1 A student shall be eligible to appear for the semester end examinations in subject if he / she acquire a **minimum of 75% of attendance in that subject.**

3.2 Shortage of attendance up to 10% in any subject (i.e., attendance of 65% and above and below 75%) in a semester may be condoned by the Institute Academic Committee based on the rules prescribed by the Academic Council of the Institute from time to time.

3.3 A student shall get **minimum required attendance in at least three (03) theory subjects** in the present semester to get promoted to the next semester. In order to qualify for the award of the M.Tech. degree, the student shall complete all the academic requirements of the subjects, as per the course structure.

3.4 Shortage of **attendance below 65% shall in NO case be condoned**.

3.5 A stipulated fee shall be payable towards condonation of shortage of attendance.

3.6 In case the student secures less than the required attendance in any subject(s), he shall not be permitted to appear for the semester end examination in that subject(s). He shall re-register for the subject when offered next.

4. Evaluation

i. The performance of a student in each semester shall be evaluated subject–wise with a maximum of **100 marks for theory** and **100 marks for practical subjects**. In addition, **mini-project** and **comprehensive viva-voce** shall be evaluated for **100 marks** respectively.

ii. For theory subjects, the distribution shall be **40 marks for mid-term evaluation** and **60 marks for the semester end examination**.

❖ **Mid-Term Evaluation (40 M):**

Mid-term evaluation consists of **mid-term examination (30 M)** and **assignment/objective test/ case study/course project (10 M).**

➢ **Mid-term examination (30 M):**

- For theory subjects, two mid-term examinations shall be conducted in each semester as per the academic calendar. Each mid-term examination shall be evaluated for 30 marks.
- Pattern of Mid-term examination:
  3 X 10M = 30 M (three internal choice questions one from each unit shall be given, the student has to answer ONE question from each unit)
- There shall be TWO mid-term examinations for each subject and the average of two mid-term examinations shall be considered for calculating final mid-term examination marks in that subject.

➢ **Assignment/objective exam/ case study/course project (10 M):**

- Two assignment/objective exam/ case study/course project shall be given to the students covering the syllabus of first mid-term and second mid-term examinations respectively and evaluated for 10 marks each.
- The first assignment/objective exam/ case study/course project shall be submitted before first mid-term examination and the second one shall be submitted before second mid-term examination.
- The average of 2 assignments shall be taken as final assignment marks.

iii. For practical subjects, there shall be a **continuous evaluation during the semester for 40 marks and 60 marks for semester end examination**. Out of the 40 marks, **day-to-day work in the laboratory shall be evaluated for 10 marks**, and **15 marks for practical examination** and **15 marks for laboratory record.**

❖ **Semester End Examination (60 M):**

(a) Theory Courses

Question paper pattern for semester end examination (60 Marks)

- Paper shall consist of 05 questions of 10 marks each. (05X12M = 60 M)
- There shall be 01 question from each unit with internal choice.

(b) Practical Courses

Each laboratory course shall be evaluated for 60 marks. The semester end examination shall be conducted by two examiners, one Internal and other external concerned with the subject of the same / other department / Industry. The evaluation shall be as per the standard format.

4.1. Evaluation of Mini-Project: There shall be two presentations during the first year, one in each semester. For mini-project 1 and mini-project 2, a student under the supervision of a faculty member, shall collect the literature on a topic, critically review the literature, carry out the mini-project, submit it to the department in a report form and shall make an oral presentation before the departmental Project Review Committee (PRC). The Departmental PRC consists of Head of the Department, supervisor and one senior faculty member of the department. For each mini-project there shall be only internal evaluation of 100 marks. A student has to secure a minimum of 50% to be declared successful.

4.2. There shall be a comprehensive viva-voce in II year I semester. The comprehensive viva- Voce shall be conducted by a committee consisting of Head of the Department and two senior faculty members of the department. The comprehensive viva-voce is aimed to assess the students' understanding in various subjects studied during the M.Tech. programme of study. The comprehensive viva-voce shall be evaluated for 100 marks by the committee. There are no internal marks for the comprehensive viva-voce. A student must secure a minimum of 50% to be declared successful.

4.3. A student shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the semester end examination and a minimum aggregate of 50% of the total marks in the semester end examination and mid-term evaluation taken together.

4.4. A student shall be given one chance to re-register, after completion of the course work, for each subject, provided the internal marks secured by a student are less than 50% and he has failed in the semester end examination. In such a case student may re-register for the subject(s) and secure required minimum attendance. Attendance in the re-registered subject(s) has to be calculated separately to become eligible to write the end examination in the re-registered subject(s). Re-registration for the subjects is allowed only if that particular re-registration subjects are the hindrance for the award of Degree. Re-registration is allowed in this case provided the student doesn't have any subject(s) yet to pass other than the re-registration subjects where the internal marks are less than 50% with prior permission.

4.5. Laboratory examination for M.Tech. courses must be conducted with two examiners, one of them being laboratory class teacher and second examiner shall be a teacher of same specialization either external or a teacher from the same department other than the teacher who conducted laboratory classes for that batch.

5. Evaluation of Project / Dissertation Work.

5.1 Registration of Project Work: A student shall be permitted to register for the project work after satisfying the attendance requirement of all the subjects (theory and practical subjects).

5.2 A Project Review Committee (PRC) shall be constituted with at least four members namely HOD, PG coordinator of the M.Tech. programme, project supervisor and one senior faculty member of same specialization.

5.3 After getting permission as per 5.1, a student has to submit, in consultation with the project supervisor, the title, objective and plan of action of his project work to the Departmental PRC for its approval. Only after obtaining the approval of PRC, the student can initiate the project work.

5.4 If a student wishes to change his supervisor or topic of the project he can do so with the approval of PRC. However, the committee shall examine whether the change of topic/supervisor leads to a major change of his initial plans of project proposal. If so, the date of registration for the project work shall be the date of change of supervisor or topic as the case may be.

5.5 Internal evaluation of the project shall be on the basis of the seminars (Project reviews) conducted during the second year by the PRC. A student shall submit draft report in a spiral bound copy form.

5.6 The work on the project shall be initiated in the beginning of the second year and the duration of project is for two semesters. A student is permitted to submit Project work only after successful completion of theory and practical course with the approval of PRC not earlier than 240 days from the date of registration of the project work. For the approval of PRC the student shall submit the draft copy of thesis to the Head of the Department (Through project supervisor and PG coordinator) and shall make an oral presentation before the PRC.

The student is eligible to submit project work if he has published at least one paper covering 70% of the project work and presented his project work in Show and Tell activity.

5.7 After approval of PRC, every student has to submit three copies of the project dissertation certified by the supervisor to the Department.

5.8 The dissertation shall be adjudicated by one examiner selected by the Chief Superintendent. For this, HOD shall submit a panel of 3/ 5 examiners, who are eminent in that field with the help of the concerned guide.

5.9 If the report of the examiner is not favourable, the student shall revise and resubmit the Dissertation, within the time frame as prescribed by PRC. If the report of the examiner is unfavourable again, the dissertation shall be summarily rejected.

5.10 If the report of the examiner is favorable, viva-voce examination shall be conducted by a board consisting of the project supervisor, Head of the Department and the external examiner who adjudicated the Thesis. The Board shall jointly report students work as:

A. Excellent
B. Good
C. Satisfactory
D. Unsatisfactory

Head of the Department shall coordinate and make arrangements for the conduct of viva-voce examination. The student has to secure any one of the grades as Excellent, Good or Satisfactory on his dissertation and viva-voce. If the report of the viva-voce is unsatisfactory, the student shall retake the viva-voce examination after three months, making modifications as suggested. If he fails to get a satisfactory report at the second viva-voce examination, he has to re-register for the project work as mentioned in clause 5.1. However, the student may select a new guide or new topic or both with the approval of the PRC and submit the project dissertation with a minimum of 240 days from the date of re-registration. Of course, this shall not prejudice the clause 6.1 below.

6. Award of Degree and Class

A student shall be declared eligible for the award of the M.Tech. degree, if he pursues a course of study and complete it successfully for **not less than two academic years** and **not more than four academic years**.

6.1 A student, who fails to fulfil all the academic requirements for the award of the degree within four academic years from the year of his admission, for any reason whatsoever, shall forfeit his seat in M.Tech. Course.

6.2 A student shall register and put up **minimum academic requirement in all 84 credits** and earn **84 credits.** Marks obtained in all 86 credits shall be considered for the calculation of Cumulative Grade Point Average (CGPA).

6.3 CGPA System:

Method of awarding absolute grades and grade points in two year M.Tech. degree programme is as follows:
Absolute Grading Method is followed, based on the total marks obtained in mid-term evaluation and semester end examinations.

- Grades and Grade points are assigned as given below.

Marks Obtained	Grade	Description of Grade	Grade Points(GP) Value Per Credit
>=90	O	Outstanding	10.00
>=80 and <89.99	A	Excellent	9.00
>=70 and <79.99	B	Very Good	8.00
>=60 and <69.99	C	Good	7.00
>=50 and <59.99	D	Pass	6.00
<50	F	Fail	
Not Appeared the Exam(s)	N	Absent	

The student is eligible for the award of the M.Tech degree with the class as mentioned in the following table.

CGPA	Class
>= 8.0	First Class with Distinction
>= 7.0 and <8.0	First Class
>= 6.0 and < 7.0	Second Class

➢ **Calculation of Semester Grade Points Average (SGPA):**

- The performance of each student at the end of the each semester shall be indicated in terms of SGPA. The SGPA shall be calculated as below:

$$\text{SGPA} = \frac{\text{Total earned weighted grade points in a semester}}{\text{Total credits in a semester}}$$

$$\text{SGPA} = \frac{\sum_{i=1}^{p} C_i * G_i}{\sum_{i=1}^{p} C_i}$$

Where Ci = Number of credits allotted to a particular subject 'i'
Gi = Grade point corresponding to the letter grade awarded to the subject 'i'
i = 1,2,…..p represent the number of subjects in a particular semester

Note: SGPA is calculated and awarded for the students who pass all the courses in a semester.

➢ **Calculation of Cumulative Grade Point Average (CGPA):**
The CGPA of a student for the entire programme shall be calculated as given below:

- Assessment of the overall performance of a student shall be obtained by calculating Cumulative Grade Point Average (CGPA), which is weighted average of the grade points obtained in all subjects during the course of study.

$$\text{CGPA} = \frac{\text{Total earned weighted grade points for the entire programme}}{\text{Total credits for the entire programme}}$$

$$\text{CGPA} = \frac{\sum_{j=1}^{m} C_j * G_j}{\sum_{j=1}^{m} C_j}$$

Where Cj = Number of credits allotted to a particular subject 'j'
Gj = Grade Point corresponding to the letter grade awarded to that subject 'j'
j = 1,2,….m represent the number of subjects of the entire program.

- Grade lower than D in any subject shall not be considered for CGPA calculation. The CGPA shall be awarded only when the student acquires the required number of credits prescribed for the program.

- **Grade Card**

  The grade card issued shall contain the following:
  a) The credits for each subject offered in that semester
  b) The letter grade and grade point awarded in each subject
  c) The SGPA/CGPA
  d) Total number of credits earned by the student up to the end of that semester.

7. Withholding of Results

If the student has not paid dues to the Institute, or if any case of indiscipline is pending against him, the result of the student may be withheld and he shall not be allowed into the next higher semester. The award or issue of the provisional certificate and the degree may also be withheld in such cases. This delay shall not prejudice clauses Nos.6.0 and 6.1.

8. Transitory Regulations

Students who have discontinued or have been detained for want of attendance or any other academic requirements, may be considered for readmission as and when they become eligible. They have to take up Equivalent subjects, as substitute subjects in place of repeated subjects as decided by the Chairman of the BoS of the respective departments. He/She shall be admitted under the regulation of the batch in which he/she is readmitted.

9. Minimum Instruction Days

The minimum instruction days for each semester shall be **90 instruction days.**

10. General

10.1 The academic regulations should be read as a whole for purpose of any interpretation.

10.2 In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal is final.

10.3 The Institute may change or amend the academic regulations and syllabi at any time and the changes and amendments made shall be applicable to all the students with effect from the date notified by the Institute.

10.4 Wherever the words he, him or his occur, they shall also include she, her and hers.

11. Supplementary Examination

Supplementary examinations shall be conducted along with regular semester end examinations. (During even semester regular examinations, supplementary examinations of odd Semester and during odd semester regular examinations, supplementary examinations of even semester shall be conducted).

VNR Vignana Jyothi Institute of Engineering & Technology

M. TECH - POWER ELECTRONICS (PE)

Vision of the Institute

To be a World Class University providing value based education, conducting interdisciplinary research in cutting edge technologies leading to sustainable socio economic development of the nation.

Mission of the Institute

- To produce technically competent and socially responsible engineers, managers and entrepreneurs who will be future ready.
- To involve students and faculty in innovative research projects linked with industry, academic and research institutions in India and abroad.
- To use modern pedagogy for improving the teaching learning process.

Vision of the Department

To excel in Education, Technology and Research in Electrical and Electronics Engineering leading to sustainable socioeconomic development of the nation.

Mission of the Department

- Excellent teaching learning environment imbibed with professional ethics and social responsibility in promoting quality education.
- Promoting research through industry collaborations and innovative projects.

VNR Vignana Jyothi Institute of Engineering & Technology

Program Educational Objectives for M.Tech Power Electronics (PE) Program:

The Post Graduates of Power Electronics program will

I. Be proficient in applying sustainable and inclusive technologies to analyse, formulate and provide solutions for real time problems in diversified fields.
II. Solve complex technological problems using emerging technologies and tools
III. Work effectively as an individual and team member with good communication skills in project execution
IV. Demonstrate interdisciplinary skills and professional ethics in relating engineering issues to broader societal context
V. Engage in life long learning for a successful professional career.

Program Outcomes for M.Tech Power Electronics (PE) Program:

The graduates will be able to

*a***.** Apply the knowledge of power electronics for the control of electrical systems.

b. Design and conduct experiments, as well as analyze the power electronic converters & drives and interpret the data.

c. Design system or component to meet the desired needs with in realistic constraints.

d. Function on multidisciplinary technological issues assimilating power electronics advancements.

e. Identify, formulate and model the power electronic systems as a solution to the problems in allied disciplines.

f. Acquire and demonstrate the professional, social, moral and ethical responsibility

g. Communicate effectively on complex engineering activities with the engineering community and with society at large.

h. Work with the independent and reflective thinking for problem solving in power electronics and allied fields

i. Recognizes the need for and engage in lifelong learning to update with or develop technologies to meet the growing and changing needs of society

j. Use the techniques, skills, and modern engineering simulation tools necessary for the design and development of power converter topologies.

k. Propose, plan and execute projects subjected to financial, personnel and time constraints in allied fields assimilating power electronics advancements.

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

M.TECH. (POWER ELECTRONICS)

(R15 Regulation)

I YEAR I SEMESTER **COURSE STRUCTURE**

Subject code	Group	Subject Name	L	P	Credits
PES01	**Core**	Machine Modeling & Analysis	3	1	4
PES02		Analysis of Power Electronic Converters –I	3	1	4
PES03		Power Electronic Control of DC Drives	3	1	4
PES11	**Elective – I & Elective – II Basket**	HVDC Transmission	3	0	3 + 3
PES12		Dynamics of Electrical Machines	3	0	
PES13		Special Machines	3	0	
PSS13		AI Techniques in Electrical Engineering	3	0	
PES14		Electric and Hybrid Vehicles	3	0	
PES15		VLSI Design	3	0	
PES31	**Open Elective I**	Microcontrollers and Applications	3	0	3
PSS31		Energy Auditing, Conservation and Management	3	0	
PES32		Advanced Digital Signal Processing	3	0	
PES51	**Lab -1**	Power Converters Simulation Lab	0	3	2
PES61		Mini Project -1	0	0	4
Total			**18**	**6**	**27**

I YEAR II SEMESTER **COURSE STRUCTURE**

Subject code	Group	Subject Name	L	P	Credits
PES04	**Core**	Analysis of Power Electronic Converters –II	3	1	4
PES05		Power Electronic Control of AC Drives	3	1	4
PES06		Modern Control Theory	3	1	4
PSS21	**Elective – III & Elective – IV Basket**	Power Quality	3	0	3 + 3
PES21		Digital Control Systems	3	0	
PES22		Embedded Systems	3	0	
PES23		Reliability Engineering	3	0	
PES25		FACTS Controllers	3	0	
PES24		Analysis and Design of Switched Mode Converters	3	0	
PES41	**Open Elective II**	Renewable Power Generation Technologies	3	0	3
PES42		Programmable Logic Controllers and their Applications	3	0	
PSS41		Optimization Techniques	3	0	
PES52	**Lab -2**	Power Converters and Drives Lab	0	3	2
PES62		Mini Project -2	0	0	4
Total			**18**	**6**	**27**

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

M.TECH. (POWER ELECTRONICS)

(R15 Regulation)

II YEAR I SEMESTER **COURSE STRUCTURE**

Subject code	Group	Subject Name	L	P	Credits
PES63		Comprehensive Viva-Voce	0	0	4
PES71		Internship/Dissertation Phase – I	0	0	8
Total			**0**	**0**	**12**

II YEAR II SEMESTER **COURSE STRUCTURE**

Subject code	Group	Subject Name	L	P	Credits
PES72		Dissertation Phase – II	0	0	18
Total			**0**	**0**	**18**

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I Year – I sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**1**	**4**

(PES01) MACHINE MODELLING AND ANALYSIS

Prerequisites: Electrical Machines (DC and AC), Control Theory

Course Objectives:

- To comprehend the basic two-pole machine.
- Identifying the methods and assumptions in modeling of machines.
- To write voltage and torque equations for different machines.
- Recognize the different frames for modeling of different AC machines.
- To express the voltage and torque equations in State space form

Course Outcomes:

- Write the voltage equation and torque equations for different machines like dc machine, induction motor and Synchronous machines.
- Model different machines using phase and Active transformations.
- Identify the different reference frames for modeling of machines.

UNIT I:

Basic Two-pole DC machine - primitive 2-axis machine - Voltage and Current relationship - Torque equation

UNIT II:

Mathematical model of separately excited DC motor and DC Series motor in state variable form - Transfer function of the motor - Numerical problems.

Mathematical model of D.C. shunt motor and D.C. Compound motor in state variable form - Transfer function of the motor - Numerical Problems.

UNIT III:

Linear transformation-Phase transformation (a,b,c to a,p,o)-Active transformation(a,p,o to d,q).Circuit model of a 3 phase Induction motor - Linear transformation - Phase Transformation - Transformation to a Reference frame - Two axis models for Induction motor.

UNIT IV:

Voltage and current Equations in stator reference frame - Equation in Rotor reference frame - Equations in a synchronously rotating frame - Torque equation-Equations in state-space form.

UNIT V:

Circuit model of a 3ph Synchronous motor - Two axis representation of Syn. Motor. Voltage and current Equations in state - space variable form - Torque equation.

Text Books:

1. Analysis of electric machinery and Drive systems- Paul C.Krause , Oleg wasynezuk, Scott D.Sudhoff, third edition, IEEE press

References:

1. Thyristor control of Electric Drives - Vedam Subramanyam, Tata McGraw-Hill Education, 1988
2. Generalized Machine theory P.S. Bimbhra, Khanna Publishers, 2002

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I Year – I sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**1**	**4**

(PES02) ANALYSIS OF POWER ELECTRONIC CONVERTERS -I

Prerequisites: Power Electronics, Electronic devices and circuits

Course Objectives:

- To comprehend the concepts of converters
- Students will be able to relate to the applications of phase controlled rectifiers
- Students will be able to describe the importance of AC voltage controllers and cyclo converters for various industrial applications
- Students will be able to analyze and design switch mode power electronic converters for various applications including microprocessor power supplies, renewable energy systems, and motor drives.
- Students will be able to analyze pulse width modulated inverters which are used in variable speed drives

Course Outcomes:

- Understand the basic principles of switch mode power converters.
- Understand the operating principles and models of different types of power electronic converters AC-AC, AC-DC, DC-AC and DC-DC converter systems.
- Select appropriate power converter topologies and design the power stage with controllers for various applications.
- Apply advanced modulation techniques for analyzing and designing power converters.

UNIT I:

Power Switching Devices: Static and dynamic characteristics of switching devices:-SCR, BJT, MOSFET, IGBT, and GTO - Gate driver circuits:-MOSFET, BJT- pulse transformers-opto couplers

Single Phase Converters: Single phase converters - Half controlled and Fully controlled converters -Evaluation of input power factor and harmonic factor - continuous and Discontinuous load current - single phase dual converters - power factor Improvements - Extinction angle control - symmetrical angle control - PWM -single phase sinusoidal PWM - single phase series converters - Applications -Numerical problems.

Three Phase Converters: Three phase converters - Half controlled and fully controlled converters -Evaluation of input power factor and harmonic factor - continuous and Discontinuous load current - three phase dual converters - power factor Improvements - three phase PWM - twelve pulse converters - applications -Numerical problems.

UNIT II:

Single Phase AC Voltage Controllers: Single phase AC voltage controllers with Resistive, Resistive-inductive and Resistive-inductive-induced e.m.f.loads - ac voltage controllers with PW Control - Effects of source and load inductances - Synchronous tap changers-Applications - numerical problems.

UNIT III:

Three Phase AC Voltage Controllers: Three phase AC voltage controllers - Analysis of controllers with star and delta Connected Resistive, Resistive-inductive loads - Effects of source and load Inductances - applications - numerical problems.

Cycloconverters: Single phase to single phase cycloconverters - analysis of midpoint and bridge Configurations - Three phase to three phase cycloconverters - analysis of Midpoint and bridge configurations - Limitations - Advantages - Applications- numerical problems.

UNIT IV:

D.C. to D.C. Converters: Analysis of step-down and step-up dc to dc converters with resistive and Resistive-inductive loads - Switched mode regulators - Analysis of Buck Regulators - Boost regulators - buck and boost regulators - Cuk regulators - Condition for continuous inductor current and capacitor voltage - comparison of regulators -Multiouput boost converters - advantages - applications - Numerical problems.

UNIT V:

Pulse Width Modulated Inverters (Single Phase): Principle of operation - performance parameters - single phase bridge inverter -evaluation of output voltage and current with resistive, inductive and Capacitive loads - Voltage control of single phase inverters - single PWM - Multiple PWM - sinusoidal PWM - modified PWM - phase displacement Control - Advanced modulation techniques for improved performance - Trapezoidal, staircase, stepped, harmonic injection and delta modulation - Advantage - application - numerical problems.

Pulse Width Modulated Inverters (Three Phase): Voltage Source Inverter-Three phase inverters - analysis of 180 degree condition for output voltage And current with resistive, inductive loads - analysis of 120 degree Conduction - voltage control of three phase inverters - sinusoidal PWM - Third Harmonic PWM – 60 degree PWM - space vector modulation - Comparison of PWM techniques- harmonic reductions - Current Source Inverter - advantages - applications - numerical problems.

Text Books:

1. Power Electronics - Mohammed H. Rashid - Pearson Education -Third Edition - First Indian reprint 2004
2. Power Electronics - Ned Mohan, Tore M. Undeland and William P. Robbins – John Wiley and Sons - Second Edition

References:

1. Power Electronics Daniel W. Hart, Tata Mc Graw Hill Education Pvt Ltd, 2011, New Delhi
2. Fundamentals of Power Electronis, 2nd Edition. R.W. Erickson
3. The power electronics Hand Book Timothy, L. Skvarenina, Purdue University

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I Year – I sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**1**	**4**

(PES03) POWER ELECTRONIC CONTROL OF DC DRIVES

Prerequisites: Power Electronics and Electrical DC machines and control systems

Course Objectives:

- Introduction of drive system and characteristics of drive ,operation modes of drive
- Detailed description of the operation, function and interaction between various components and sub-systems used in power electronic converters, electric machines and adjustable-speed drives
- Comprehend the principle operation of phase control and Chopper controlled of dc drives
- Design of current and speed controllers
- Dynamic simulations of the speed controlled DC motor drives.

Course Outcomes:

- Comprehend various controllers for DC drives
- Understand the principle of operation of power electronic control of electric drive system.
- Assess the performance of speed –torque characteristics of phase controlled and chopper controlled motor drives
- Identify and select the speed and current control strategies of drives

UNIT I:

1- ϕ Controlled Bridge Rectifier Fed DC Motor: Introduction- characteristics and operating modes of drives -Separately excited DC motors with rectified single-phase supply – single-phase semi converter and single phase full converter for continuous and discontinuous modes of operation – power and power factor

UNIT II:

3- ϕ Controlled Bridge Rectifier Fed DC Motor: Three-phase semi converter and Three phase full converter for continuous and discontinuous modes of operation – power and power factor – Addition of Free wheeling diode – Three phase double converter

Three Phase Naturally Commutated Bridge Circuit as a Rectifier or as an Inverter: Three phase controlled bridge rectifier with passive load impedance, resistive load and ideal supply – Highly inductive load and ideal supply for load side and supply side quantities, shunt capacitor compensation, three phase controlled bridge rectifier inverter.

UNIT III:

Phase Controlled DC Motor Drives: Three phase controlled converter, control circuit, control modeling of three phase converter – Steady state analysis of three phase converter control DC motor drive – Two quadrant, Three phase converter controlled DC motor drive – DC motor and load, converter

Current and Speed Controlled DC Motor Drives: Current and speed controllers – current and speed feedback – Design of controllers – Current and speed controllers – Motor equations – filter in the sped feed back loop speed controller – current reference generator – current controller and flow chart for simulation – Harmonics and associated problems – sixth harmonics torque.

UNIT IV:

Chopper Controlled DC Motor Drives: Principle of operation of the chopper – Four- quadrant chopper circuit – Chopper for inversion – Chopper with other power devices – model of the chopper – input to the chopper – steady state analysis of chopper controlled DC motor drives – rating of the devices – Pulsating torque.

Closed Loop Operation of DC Motor Drives: Speed controlled drive system – current control loop – pulse width modulated current controller – hysterisis current controller – modeling of current controller – design of current controller

UNIT V:

Simulation of DC Motor Drives: Dynamic simulations of the speed controlled DC motor drives – Speed feedback controller – command current generator – current controller.

Text Books:

1. Power Electronics and motor control – Shepherd, Hulley, Liang – II Edition, Cambridge University Press
2. Electric motor drives modeling, Analysis and control – R.Krishnan – I Edition, Prentice Hall India

References:

1. Power Electronic circuits, Devices and Applications – M.H.Rashid – PHI – I Edition – 1995
2. Fundamentals of Electric Drives – G.K. Dubey- Narosa Publications -1995
3. Power Semiconductor drives – S.B.Dewan and A.Straughen – 1975, John Wiley and Sons, 1984

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I Year – I Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**0**	**3**

Elective I and II

(PES11) H.V.D.C. TRANSMISSION

Prerequisites: Power Electronics, power systems

Course Objectives:

- To Comprehend the conversion principles of HVDC Transmission
- Analysis of 3,6 , 12 pulse converters, rectifier and inverter operations of HVDC converters
- To identify the different types of Harmonics and reduction by using Filters
- To Comprehend Interaction between HVAC and DC systems in various aspects
- To appreciate the reliable MTDC systems and protection of HVDC system

Course Outcomes:

- Find the applications of HVDC transmission in the power system with the acquired knowledge.
- Analyze different converter topologies viz. 3,6 and 12 Pulse converters and understand it's control aspects.
- Understand the filter configuration for Harmonics in HVDC systems.
- Appreciate the reliable Multi terminal HVDC system.
- Have knowledge on the Protection of HVDC systems against transient over voltages and over currents.

UNIT I:

Introduction: General consideration, Power Handling Capabilities of HVDC Lines Basic Conversion principles, static converter configuration.

UNIT II:

Static Power Converters: 3-pulse, 6-pulse, and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – Analysis of VSC based HVDC system, special features of converter transformers. Harmonics in HVDC Systems, Harmonic elimination, AC and DC filters.

UNIT III:

Control of HVDC Converters and Systems: Constant current, constant extinction angle and constant ignition angle control Individual phase control and equidistant firing angle control DC power flow control. Control of VSC based HVDC system- Direct Control and Vector Control. Interaction between HV AC and DC systems – Voltage interaction Harmonic instability problems and DC power modulation.

UNIT IV:

MTDC Systems & Over Voltages: Series parallel and series parallel systems their operation and control. Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults.

UNIT V:

Converter Faults & Protection: Converter faults, over current protection – valve group, and DC line protection over voltage protection of converters, surge arresters.

Text Books:

1. E.W. Kimbark: Direct current Transmission Volume-1, Wiely Inter Science, 1971 – New York
2. KR Padiyar : High Voltage Direct current Transmission Wiely Esatern Ltd New Delhi – 1992.

References:

1. J. Arillaga HVDC Transmission Peter Peregrinus ltd. London UK 1983
2. E. Uhlman : Power Transmission by Direct Current , Springer Verlag, Berlin Helberg. 1985.
3. S. Rao "EHVAC and HVDC Transmission Engg. Practice, heory, Practice and Solved Problems 1990, Khanna publishers.

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I Year – I Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**0**	**3**

Elective –I and II

(PES12) DYNAMICS OF ELECTRICAL MACHINES

Prerequisites: Electrical machines, Control System, Network Analysis

Course Objectives:

- Formulate mathematical models of DC, synchronous and induction machine.
- Examine transient characteristic of electrical machines based on their mathematical models.
- Illustrate simulation of DC, synchronous and induction machines.
- Modify machine parameters by combining analytic and simulated results

Course Outcomes:

- Model the electrical machines and analyze transient responses in electrical machines.
- Analyze an electrical machine using a linear or a nonlinear dynamic models.
- Compute the dynamic parameters of electrical machines and to develop solutions to specific technical problems in the field of controlled electrical drives

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UNIT I:

Basic Machine Theory: Electromechanical Analogy – Magnetic Saturation – Rotating field theory – Operation of Inductor motor – equivalent circuit – Steady state equations of d.c. machines – operation of synchronous motor – Power angle characteristics.

UNIT II:

Electro Dynamical Equations and their Solutions: Spring and Plunger system – Rotational motion – mutually coupled coils – Lagrange's equation – Application of Lagrange's equation – solution of Electro dynamical equations.

UNIT III:

Dynamics of D.C. Machines: Separately excited d.c. generators – stead state analysis – transient analysis – Separately excited d.c. motors – steady state analysis – transient analysis – interconnection of machines – Ward Leonard system of speed control.

UNIT IV:

Induction Machine Dynamics: Induction machine dynamics during starting and braking – accelerating time – Induction machine dynamics during normal operation – Equation for dynamical response of the Induction motor.

UNIT V:

Synchronous Machine Dynamics : Electromechanical equation – motor operation – generator operation – small oscillations – general equations for small oscillations – representation of the oscillation equations in state variable form.

Text Books:

1. Bimbhra P.S. "Generalized Theory of Electrical Machines", Khanna Publishers 2002.

References:

1. Electrcial Machines Dynamics & Control. Sayed. A. Naser, Ion Bolder, CRC Press, 1992
2. Bimbhra P.S. "Generalized Theory of Electrical Machines", Khanna Publishers 2002.
3. Dynamics of saturated Electrical Machines, Ostovic Vlado, e – book

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I Year – I Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**0**	**3**

Elective –I and II

(PES13) SPECIAL MACHINES

Prerequisites: Electrical Machines

Course Objectives:

- To know the use of special machines in different feed-back systems
- To understand the use of micro-processors for controlling different machines
- To know their applications as control systems components

Course Outcomes:

Upon the completion of this subject, the student will be able

- To use different special machines as part of control system components
- To use special machines as transducers for converting physical signals into electrical signals
- To use micro-processors for controlling different machines
- To select different special machines as control system components

UNIT I:

Stepper Motors: Constructional features, principle of operation, modes of excitation, single phase stepping motors, torque production in variable Reluctance (VR) stepping motor, Dynamic characteristics, permanent magnet type Stepper Motor and Hybrid stepper Motors. Open loop control, Closed loop control of stepping motor, microprocessor based controller.

UNIT II:

Synchronous Reluctance Motors: Constructional features: axial and radial air gap Motors. Operating principle, reluctance torque –Phasor diagram, motor characteristics, linear induction motors.

UNIT III:

Switched Reluctance Motors: Constructional features, principle of operation. Torque equation, Power controllers, Characteristics and control. Microprocessor based controller. Sensor less control.

UNIT IV:

Permanent Magnet Brushless DC Motors: Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Controllers-Microprocessor based controller. Sensorless control.

UNIT V:

Permanent Magnet Synchronous Motors: Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self control, Vector control, Current control schemes. Sensor less control.

Permanent Magnet Axial Flux (PMAF) Machines: Construction, Armature windings – Toroidal Stator and Trapezoidal Stator Windings, Torque and EMF equations, Phasor diagram and output equation.

Text Books:

1. Brushless Permanent Magnet and Reluctance Motor Drives by T.J.E. Miller, Clarendon Press, Oxford, 1989.
2. Stepping Motors – A Guide to Motor Theory and Practice by P.P. Aearnley, Peter Perengrinus, London, 1982.
3. Special electrical machines, K. Venkataratnam, University press, 2009
4. Special electrical machines, E. G. Janardanan, Eastern Economy Edition, PHI.

References:

1. T. Kenjo, Stepping Motors and Their Microprocessor Controls, Clarendon Press London, 1984.
2. Permanent Magnet and Brushless DC Motors byT. Kenjo and S. Nagamori, Clarendon Press, London, 1988.
3. Special Electrical Machines by K.Venkataratnam, University press, 2008.
4. Generalized theory of electrical machines by P.S.Bimbra, Khanna Publications, 4th edition.

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Elective –I and II

(PSS13) AI TECHNIQUES IN ELECTRICAL ENGINEERING

Prerequisites: Control Systems, Power Systems, Electrical Drives

Course Objectives:

- To locate soft commanding methodologies, such as artificial neural networks, Fuzzy logic and genetic Algorithms.
- To observe the concepts of feed forward neural networks and about feedback neural networks.
- To practice the concept of fuzziness involved in various systems and comprehensive knowledge of fuzzy logic control and to design the fuzzy control
- To analyze genetic algorithm, genetic operations and genetic mutations.

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Quote feed forward neural networks and learning and understanding of feedback neural networks.
- Generalize fuzziness involved in various systems and fuzzy set theory.
- Select fuzzy logic control and design
- Examine genetic algorithm and applications in electrical engineering.

UNIT I:

Artificial Neural Networks: Introduction to AI, classification of AI techniques - Knowledge representation -Models of Neural Network - Architectures –Learning process - Learning Rules and Algorithms – Error correction learning – Hebbian learning –Competitive learning — Supervised learning – Unsupervised learning– Reinforcement learning- learning tasks.

UNIT II:

Single & Multilayer Feed Forward Neural Networks: Introduction, Perceptron Models: Training Algorithms: Importance of Perception Convergence theorem, Limitations of the Perceptron Model, Applications. Generalized Delta Rule, Derivation of Backpropagation (BP) Training, Summary of Backpropagation Algorithm, Learning Difficulties and Improvements, Applications.

UNIT III:

Fuzzy Logic: Introduction – Fuzzy versus crisp – Fuzzy sets - Membership function – Basic Fuzzy set operations – Properties of Fuzzy sets –Operations on Fuzzy relations – Min Max operations - Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

UNIT IV:

Genetic Algorithms: Introduction-Encoding –Fitness Function-Reproduction operators-Genetic Modeling –Genetic operators-Crossover-Single – site crossover-Two point crossover –Multi point crossover-Uniform crossover – Matrix crossover-Crossover Rate-Inversion & Deletion – Mutation operator – Mutation –Mutation Rate-Bit-wise operators-Generational cycle-convergence of Genetic - Problems on optimization-Algorithm

UNIT V:

Applications of AI Techniques: Control and Process Monitoring, fault diagnosis and load forecasting, Function Approximation, – Load flow studies – Economic load dispatch – Load frequency control –Single area system and two area system – Position and speed control of DC and AC Motors.

Text Books:

1. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic & Genetic Algorithms"-PHI, New Delhi, 2003.
2. Bart Kosko,"Neural Network & Fuzzy System" Prentice Hall, 1992.

References:

1. P.D.Wasserman,Van Nostrand Reinhold,"Neural Computing Theory & Practice" New York,1989.
2. G.J.Klir and T.A.Folger,"Fuzzy sets,Uncertainty and Information"-PHI, Pvt.Ltd,1994.
3. D.E.Goldberg," Genetic Algorithms"- Addison Wesley 1999.

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Elective –I and II

(PES14) ELECTRIC AND HYBRID VEHICLES

Course Prerequisites: Physics, Basic Electrical Engineering.

Course Objectives:

- Study the concepts and drivetrain configurations of electric drive vehicles
- provide different electric propulsion systems and energy storage devices
- Explain the technology, design methodologies and control strategy of electric drive vehicles
- Emphasize on solar and fuel cell applications in automobiles

Course Outcomes:

Student should be able to

- Understand the concepts and drivetrain configurations of electric drive vehicles
- Present different electric propulsion systems and energy storage devices
- Discuss the technology, design methodologies and control strategy of electric drive vehicles
- Appreciate the solar and fuel cell applications in automobiles

UNIT I:

Electric Vehicles: Layout of an electric vehicle, performance of electric vehicles, traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, advantage and limitations, specifications, system components and electronic control system.

UNIT II:

Hybrid Vehicles: Concepts of hybrid electric drive train, types, architecture of series and parallel hybrid electric drive train, merits and demerits, series and parallel hybrid electric drive train design.

UNIT III:

Electric Propulsion Systems: DC motor drives, Induction motor drives, permanent magnet brushless DC motor drives and switched reluctance motor drives.

UNIT IV:

Motor Controllers and Control Systems: Control system principles, speed and torque control – DC motors and AC motors.

UNIT V:

Energy Storages: Electromechanical batteries - Types of batteries, lead acid batteries, nickel based batteries, lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency and ultracapacitors.

Text Books:

1. Mehrdad Ehsani, Yimin Gao, sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design”, CRS Press, 2004.

2. James Larminie and John Loury, “Electric Vehicle Technology-Explained”, John Wiley & Sons Ltd., 2003.

References:

1. Sandeep Dhameja, “Electric Vehicle Battery Systems”, Butterworth –Heinemann, 2002.
2. Ronald K Jurgen, “Electric and Hybrid – Electric Vehicles”, SAE, 2002.
3. Ron Hodkinson and John Fenton, “Light Weight Electric/Hybrid Vehicle Design”, Butterworth- Heinemann publications, 2001

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	3	**0**	**3**

Elective –I and II

(PES15) VLSI DESIGN

Prerequisites:

- Basics of VLSI Design and Semiconductor Physics.

Course Objectives:

- To comprehend basic electrical properties of MOS transistor technologies.
- To discuss layouts for combinational circuits with different alternate gate structures.
- To understand different MOS technologies and their fabrication processes .
- To learn about IC package functions and operations.

Course Outcomes:

After going through this course the student will able to

- Analyze the relation between various MOS Transistors parameters.
- Design layouts with different alternate gate structures.
- Apply the concept of fabrication process in manufacturing ICs.
- Understand the Bi-CMOS characteristics and package operations.

UNIT I:

Review of Microelectronics and Introduction to MOS Technologies: MOS, CMOS, Bi-CMOS Technology. Basic Electrical Properties of MOS, CMOS & Bi-CMOS Circuits: $I_{ds} - V_{ds}$ relationships, Threshold Voltage V_T, G_m, G_{ds} and ω_o, Pass Transistor, MOS, CMOS & Bi-CMOS Inverters, Z_{pu}/Z_{pd}, MOS Transistor circuit model, Latch-up in CMOS circuits.

UNIT II:

Layout Design and Tools: Transistor structures, Wires and vias, Scalable Design rules, Layout Design tools.

Logic Gates & Layouts: Static Complementary Gates, Switch Logic, Alternative Gate circuits, Low power gates, Resistive and Inductive interconnect delays.

UNIT III:

Overview of semiconductor industry, Stages of Manufacturing, Process and product trends, Crystal growth, Basic wafer fabrication operations, process yields, Semiconductor material preparation, Basic wafer fabrication operations, Yield measurement, Contamination sources, Clean room construction, Oxidation and Photolithography, Doping and Depositions, Metallization. Ten step patterning process, Photoresists, physical properties of photoresists, Storage and control of photoresists, photo masking process, Hard bake, develop inspect, Dry etching Wet etching, resist stripping

UNIT IV:

Doping and Depositions: Diffusion process steps, deposition, Drive-in oxidation, Ion implantation-1, Ion implantation-2, CVD basics, CVD process steps, Low pressure CVD systems, Plasma enhanced CVD systems, Vapor phase epitoxy, molecular beam epitaxy.

UNIT V:

Design Rules and Scaling, BI-CMOS ICs: Choice of transistor types, pnp transistors, Resistors, capacitors.

Packaging: Chip characteristics, package functions, package operations

Text Books:

1. Essentials of VLSI circuits and systems – Kamran Eshraghian, Dougles and A. Pucknell, PHI Edition, 2005.
2. Microchip fabrication- Peter Van Zant,, McGraw Hill, 1997.
3. ULSI technology - C.Y. Chang and S.M. Sze, McGraw Hill, 2000
4. Modern VLSI Design –Wayne Wolf, Pearson Education , 3rd Edition, 1997.

References:

1. Micro Electronics circuits Analysis and Design 2nd Edition, Muhammad H Rashid, CENAGE Learning2011.
2. Introduction to VLSI design - Eugene D. Fabricius, McGraw Hill, 1999
3. The VLSI Hand book - Wani-Kai Chen (editor),CRI/IEEE press, 2000
4. VLSI Fabrication principles - S.K. Gandhi, John Wiley and Sons, NY, 1994

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I Year – I Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**0**	**3**

(Open Elective-I)

(PSS31) MICROCONTROLLERS AND APPLICATIONS

Prerequisite: None

Course Objectives:

- To relate the basic architecture and addressing modes of a stored-program computer.
- To summarize the principles of top down design to microcontroller software development
- To demonstrate assembly language programs for the advanced Microcontroller , assembly language code for high-level language structures such as IF-THEN-ELSE and DO-WHILE
- To analyze a typical I/O interface and to discuss timing issues
- To identify different types of memory used in microcontroller systems

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Distinguish Types of computers & microcontrollers,
- Construct Real time Applications of Microcontrollers.
- Demonstrate RTOS for Microcontrollers.
- Translate Hardware applications using Microcontrollers.

UNIT I:

Overview and Architecture of 8051 Resources: Architecture of a microcontroller – Microcontroller resources – 8051 microcontroller – Internal and External memories – Counters and Timers – Synchronous serial-cum asynchronous serial communication

UNIT II:

8051- Microcontrollers Instruction Set: Basic assembly language programming – Data transfer instructions – Data and Bit-manipulation instructions – Arithmetic instructions – Instructions for Logical operations on the test among the Registers, Internal RAM, and SFRs – Program flow control instructions – Interrupt control flow.

UNIT III:

8051 Real Time Control: Interrupt handling structure of an MCU – Interrupt Latency and Interrupt deadline– Multiple sources of the interrupts – Non-mask able interrupt sources – Enabling or disabling of the sources – Polling to determine the interrupt source and assignment of the priorities among them – Interrupt structure in Intel 8051.

UNIT IV:

Systems Design Digital and Analog Interfacing Methods: Switch, Keypad and Keyboard interfacings – LED and Array of LEDs, ADC and DAC Interfacing to 8051 – Programmable instruments interface using IEEE 488 Bus – Interfacing with the Flash Memory – Optical motor shaft encoders – Industrial control – Industrial process control system – Prototype MCU based Measuring instruments – Robotics and Embedded control

UNIT V:

Real Time Operating System & ARM7: Real Time operating system – RTOS of Keil (RTX51) – Use of RTOS in Design – Software development tools for Microcontrollers.

ARM7: Introduction to 32 bit processors – ARM architecture and organization – ARM / Thumb programming model – ARM / Thumb instruction set – Development tools.

Text Books:

1. Raj Kamal," Microcontrollers Architecture, Programming, Interfacing and System Design"– Pearson Education, 2005.
2. Mazidi and Mazidi, "The 8051 Microcontroller and Embedded Systems" – PHI, 2000.

References:

1. A.V. Deshmuk, "Microcontrollers (Theory & Applications)" – WTMH, 2005.
2. John B. Peatman, "Design with PIC Microcontrollers" – Pearson Education, 2005.
3. Microcontroller Programming, Julio Sanchez, Maria P. Canton, CRC Press.
4. The 8051 Microcontroller, Ayala, Cengage Learning.
5. Microprocessors and Microcontrollers, Architecture, Programming and System Design, Krishna Kant, PHI Learning PVT. Ltd.
6. Microprocessors, Nilesh B. Bahadure, 2010,PHI Learning PVT. Ltd.

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I Year – II Sem M.Tech (Power Systems)	**L**	**T/P/D**	**C**
	3	**0**	**3**

(Open Elective-I)

(PSS31) ENERGY AUDITING, CONSERVATION AND MANAGEMENT

Prerequisite: None

Course Objectives:

- To know the necessity of conservation of energy
- To generalize the methods of energy management
- To illustrate the factors to increase the efficiency of electrical equipment
- To detect the benefits of carrying out energy audits.

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Tell energy audit of industries
- Predict management of energy systems
- Sequence the methods of improving efficiency of electric motor
- Analyze the power factor and to design a good illumination system
- Determine pay back periods for energy saving equipment

UNIT I:

Basic Principles of Energy Audit: Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.

UNIT II:

Energy Management: Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting- Energy manager, Qualities and functions, language, Questionnaire – check list for top management.

UNIT III:

Energy Efficient Motors: Energy efficient motors , factors affecting efficiency, loss distribution , constructional details , characteristics - variable speed , variable duty cycle systems, RMS hp-voltage variation-voltage unbalance- over motoring- motor energy audit

UNIT IV:

Power Factor Improvement, Lighting and Energy Instruments: Power factor – methods of improvement, location of capacitors, Pf with non linear loads, effect of harmonics on power factor, power factor motor controllers - Good lighting system design and practice, lighting control ,lighting energy audit - Energy Instruments- wattmeter, data loggers, thermocouples, pyrometers, lux meters, tongue testers ,application of PLC's.

UNIT V:

Economic Aspects and Analysis: Economics Analysis-Depreciation Methods, time value of money, rate of return , present worth method , replacement analysis, life cycle costing analysis- Energy efficient motors- calculation of simple payback method, net present worth method- Power factor correction, lighting - Applications of life cycle costing analysis, return on investment .

Text Books:

1. Energy management by W.R. Murphy AND G. Mckay Butter worth, Heinemann publications.
2. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998

References:

1. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd-2nd edition, 1995-
2. Energy management hand book by W.C.Turner, John wiley and sons
3. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

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(Open Elective-I)

(PES32) ADVANCED DIGITAL SIGNAL PROCESSING

Prerequisite: None

Course Objectives:
i. To have an overview of signals and systems and DFT & FFT Transforms.
ii. To study the design of IIR & FIR filters.
iii. To study the applications of DSP techniques in processors.

Course Outcome:
At the end of the course, the student will be able to:
i. Understand types of digital signals and Transforms and its application to signals and systems.
ii. Design of IIR & FIR filters.
iii. Understand different DSP processors and basic programming skills.

UNIT I:
Review of Discrete Time Systems: Discrete time Signals-Sequences –Stability and Causality – Frequency domain Representation of Discrete time Systems and Signals –Two-dimensional Sequences and Systems –Z-Transform –ZTransform Theorems and Properties –Two-dimensional Z Transform. Structures for discrete time system – Direct, cascade and parallel forms –Lattice structure.

UNIT II:
Discrete Fourier Transform: Representation of Periodic Sequences-the Discrete Fourier Series –Properties of the discrete Fourier series –Sampling, Z-transform –discrete Fourier transform – properties of discrete Fourier Transform –Linear Convolution –Decimation –in- Time and Decimation in- Frequency –FFT Algorithms

UNIT III:
Digital Filter Design Techniques: Introduction – Design of IIR Digital Filters from Analog Filters –Analog –Digital Transformation –Properties of FIR Digital Filters –Design of FIR Filters Using Windows –A Comparison of IIR and FIR Digital Filters.

UNIT IV:
Finite Register Length Effects: Introduction - Effects of coefficient on Quantization – Quantization in Sampling -Analog Signals- Finite Register Length effects in realizations of Digital Filters – discrete Fourier Transform Computations.

UNIT V:
Advanced DSP Processors: Commercial DSP devices – TMS C240 processor, TMS320C, ADSP 2181 processor –Architecture – Addressing modes – Program control – Instruction and programming –Simple programs.

References:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, “Digital Signal Processing: A Practical Approach”, Pearson Education India Series, New Delhi, 2nd Edition, 2004
2. Sanjit K Mitra, “Digital Signals Processing: A Computer Based Approach”, Tata McGraw-Hill Publishing Company Limited, New Delhi 2nd Edition, 2004.
3. Alan Oppenheim. V and Ronald W.Schafer, “Digital Signal Processing”, Prentice Hall of
4. India Private.Limited. New Delhi,2ndEdition 1989.
5. John G. Proakis and Manolakis. D.G, “Digital Signal Processing: Principles Algorithms and Applications,” Prentice Hall of India, New Delhi, 2004.
6. Avatar Singh and Srinivasan. S , “ Digital Signal Processing: Implementation using DSP
7. Microprocessors with Examples from TMS 320C54XX, Thompson Brooks/Cole,Florence, USA 2004.

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	0	**3**	**2**

(PES51) POWER CONVERTERS SIMULATION LAB

Pre-requisites: All core subjects and suitable simulation softwares

Course Objectives:

- Students must be able to write the programs for the given problem / system using suitable software
- Students must be able to model the given problem / system using suitable software

Course Outcomes :

Student will be able to

1. Acquire knowledge about potential softwares used in electrical engineering.
2. Choose and simulate any problem related to Power Electronics and allied fields using appropriate soft wares
3. Validate the obtained results and maintain the record

LIST OF EXPERIMENTS:

1. Single Phase Controlled Rectifiers with R, RL and RLE loads.
2. Three Phase Controlled Rectifiers with R, RL and RLE loads.
3. DC-DC Converters with RL Load.
4. Single Phase AC Voltage controller with RL load.
5. Three Phase AC Voltage controller with RL load.
6. Single Phase Cyclo Converter with RL load.
7. Three Phase Cyclo Converter with RL load.
8. Three Phase Matrix Converter with RL load.
9. Single-Phase Inverter using PWM Controller with RL Load.
10. Three-Phase Inverter using PWM Controller with RL Load.
11. Modelling of DC machines
12. Modelling of Induction Machines
13. Modelling of Synchronous Machines
14. Phase controlled rectifier fed DC Motor Drive
15. Chopper fed DC motor Drive
16. Three Phase Voltage source inverter fed Induction Machine
17. Three Phase current source inverter fed Induction Machine
18. Three Phase AC voltage controller fed Induction Machine

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	0	**6**	**4**

(PES61) MINI PROJECT-I

Course Objectives:

- To improve the capability of surveying for required literature.
- To inculcate the design ability of electrical systems
- To enhance the skills of fabricating the hardware projects
- To correlate the experimental results with theoretical/designed data.

Course Outcomes:

- Carry out Literature study and give problem statement
- Select Control Strategy, design methodology and develop a suitable model for the chosen problem
- Execute and validate the Model
- Communicate effectively
- Write a technical report

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I Year – II Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**1**	**4**

(PES04) ANALYSIS OF POWER ELECTRONICS CONVERTERS – II

Prerequisites: Power Electronics, Electronic devices and circuits

Course Objectives:

- To understand the operation of various semi conductor devices
- To analyze resonant pulse converters
- To describe the operation of multi level inverters with switching strategies for high power
- applications
- to appreciate the design of switch mode power supplies.

Course Outcomes:

Upon completion of this course, students should be able to:

- Comprehend the semiconductor device switch characteristics
- Analyze and assess multilevel inverters and resonant pulse converters
- To design switch mode power supplies

UNIT I:

Resonant Pulse Inverters: Resonant pulse inverters – series resonant inverters – series resonant inverters With unidirectional switches – series resonant inverters with bidirectional Switches – analysis of half bridge resonant inverter – evaluation of currents and Voltages of a simple resonant inverter – analysis of half bridge and full bridge resonant inverter with bidirectional switches – Frequency response of series resonant inverters – for series loaded inverter – for parallel loaded inverter – For series and parallel loaded inverters – parallel resonant inverters – Voltage control of resonant inverters – class E resonant inverter – class E resonant rectifier – evaluation of values of *C*'s and *L's* for class E inverter and Class E rectifier – numerical problems.

Resonant Converters: Resonant converters – zero current switching resonant converters – L type ZCS resonant converter – M type ZCS resonant converter – zero voltage Switching resonant converters – comparison between ZCS and ZVS resonant converters – Two quadrant ZVS resonant converters – resonant dc-link Inverters – evaluation of L and C for a zero current switching inverter – Numerical problems.

UNIT II:

Multilevel Inverters: Multilevel concept – Classification of multilevel inverters – Diode clamped Multilevel inverter – principle of operation – main features – improved diode clamped inverter – principle of operation –Flying capacitors multilevel inverter -principle of operation – main features – cascaded multilevel inverter – principle of operation – main features – Multilevel inverter applications – reactive power compensation – back to back intertie system – adjustable drives -Switching device currents – dc link capacitor voltage balancing – features of Multilevel inverters – comparisons of multilevel converters.

UNIT III:

DC Power Supplies: DC power supplies – classification - switched mode dc power supplies – flyback Converter – forward converter – push-pull converter – half bridge converter – Full bridge converter – Resonant d c power supplies – bidirectional power Supplies – Applications.

UNIT IV:

AC Power Supplies: AC power supplies – classification – switched mode ac power supplies – Resonant AC power supplies – bidirectional ac power supplies – multistage conversions – control circuits – applications.

Power Conditioners and Uninterruptible Power Supplies: Introduction – power line disturbances – power conditioners – uninterruptible Power supplies – applications.

UNIT V:

Protection of Devices and Circuits: Introduction Cooling and Heat Sinks- Thermal modeling of power switching devices- snubber circuits- reverse recovery transients- voltage protection by selenium diodes and metal oxide varistors- current protection- electromagnetic interference

Text Books:

1. Power Electronics – Mohammed H. Rashid –Pearson Education – Third Edition – first Indian reprint – 2004.
2. Power Electronics – Ned Mohan , Tore M. Undeland and William P. Robbins – John Wiley & Sons –Second Edition.

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I Year – II Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**1**	**4**

(PES05) POWER ELECTRONIC CONTROL OF A.C. DRIVES

Prerequisites: Power Electronics, AC machines and control systems

Course Objectives:

- Detailed Explanation of the operation, function and interaction between various components and sub-systems used in power electronic converters, electric machines and adjustable-speed drives
- To Comprehend the scalar and vector control for ac motor drive (IM and SM)
- To explain the static resistance control and Slip power recovery drives
- To explain synchronous motor drive characteristics and its control strategies
- To Comprehend the brushless dc motor principle of operation.

Course Outcomes:

- Understand the principle of operation of ac motor to derive the torque equation and speed torque slip characteristics.
- Assess the performance characteristics of voltage controlled induction motor drives, frequency controlled induction motor drives and vector control drive.
- Comprehend the ac drive control strategies
- Recognize the difference between the conventional and static rotor resistance control methods and significance of slip power recovery drives.
- Analyses the operation of variable reluctance motor and brushless dc motor drives

UNIT I:

Introduction to AC Drives: Introduction to motor drives – Torque production – Equivalent circuit analysis – Speed-Torque Characteristics with Variable voltage operation, Variable frequency operation, constant v/f operation – Variable stator current operation – Induction motor characteristics in constant torque and field weakening regions

UNIT II:

Control of Induction Motor Drives at Stator Side: Scalar control – Voltage fed inverter control – Open loop volts/Hz control – speed control slip regulation – speed control with torque and flux control – current controlled voltage fed inverter drive – current-fed inverter control – Independent current and frequency control – Speed and flux control in Current-Fed inverter drive – Volts/Hz control of Current-fed inverter drive – Efficiency optimization control by flux program

UNIT III:

Control of Induction Motor Drives at Rotor Side: Slip power recovery drives – Static Kramer Drive – Phasor diagram –Torque expression - Speed control of a Kramer Drive – Static Scheribus Drive – modes of operation

Vector Control of Induction Motor Drives:

Principles of Vector control – Vector control methods – Direct method of vector control – Indirect method of vector control – Principle of Direct Torque Control- fundamentals of producing fast torque response-Adaptive control principles – Self tuning regulator – Model referencing control.

UNIT IV:

Control of Synchronous Motor Drives:

Synchronous motor and its characteristics – Control strategies – Constant torque angle control – unity power factor control Constant mutual flux linkage control

Controllers: Flux weakening operation – Maximum speed – Direct flux weakening algorithm – Constant Torque mode controller – Flux Weakening controller – Indirect flux weakening – Maximum permissible torque – speed control scheme – Implementation strategy – Speed controller design.

UNIT V:

Variable Reluctance Motor Drive: Variable Reluctance motor drives - Torque production in the variable reluctance motor – Drive characteristics and control principles – Current control variable reluctance motor servo drive

Brushless DC Motor Drives: Three phase full wave Brushless dc motor – Sinusoidal type of Brushless dc motor – current controlled Brushless dc motor Servo drive

Text Books:

1. Modern Power Electronics and AC Drives – B.K.Bose – Pearson Publications – 1st edition
2. Power Electronics and AC Drives – B.K.Bose – Prentice Hall, Eagle wood diffs New Jersey(for chapters I, II, IV) – 1st edition
3. Electric Motor Drives Pearson Modeling, Analysis & Control – R.Krishnan – Publications – 1st edition – 2002
4. Power Electronic control of AC Motors – MD Murphy & FG Turn Bull Pergman Press(For Chapters II, III, V) – 1st edition

References:

1. Power Electronic circuits, Devices and Applications – M.H.Rashid – PHI - 1995
2. Fundamentals of Electrical Drives – G.K.Dubey – Narora publications - 1995
3. (For Chapter II)
4. Power Electronics and Variable frequency drives – B.K.Bose – IEEE Press – Standar publications -1st edition – 2002
5. Sensorless Vector and Direct Torque Control- Peter Vas-Oxford University Press-1998

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I Year – II Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**1**	**4**

(PES06) MODERN CONTROL THEORY

Prerequisites : Linear control systems

Course Objectives:

- To explain the concepts of basic and modern control system for the real time analysis and design of control systems.
- To Explain and apply concepts of state variables analysis.
- To study and analyze non linear systems.
- To Analyze the concept of stability of nonlinear systems and categorization.
- To apply the comprehensive knowledge of optimal theory for Control Systems.

Course Outcomes:

- Apply the knowledge of basic and modern control system for the real time analysis and design of control systems.
- Understand the concepts of state variable analysis
- Analyze the concept of stability of nonlinear systems and optimal control

UNIT I:

Mathematical Preliminaries: Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms – Eigenvalues, Eigen Vectors and a Canonical form representation of Linear operators – The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Nonuniqueness of state model – State diagrams for Continuous-Time State models –

UNIT II:

State Variable Analysis: Linear Continuous time models for Physical systems– Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and it's properties

Controllability and Observability: General concept of controllability – General concept of Observability – Controllability tests for Continuous-Time Invariant Systems – Observability tests for Continuous-Time Invariant Systems – Controllability and Observability of State Model in Jordan Canonical form – Controllability and Observability Canonical forms of State model

UNIT III:

Non Linear Systems -I: Introduction – Non Linear Systems - Types of Non-Linearities – Saturation – Dead-Zone - Backlash – Jump Phenomenon etc;– Singular Points – Introduction to Linearization of nonlinear systems, Properties of Non-Linear systems – Describing function– describing function analysis of nonlinear systems – Stability analysis of Non-Linear systems through describing functions

Non Linear Systems -II: Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems.

UNIT IV:

Stability Analysis: Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems - Stability Analysis of the Linear continuous time invariant systems by

Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

State Feedback Controllers and Observers:

State feedback controller design through Pole Assignment – State observers: Full order and Reduced order

UNIT V:

Introduction to optimal control - Formulation of optimal control problems – calculus of variations – fundamental concepts, functionals, variation of functionals – fundamental theorem of theorem of Calculus of variations – boundary conditions – constrained minimization – formulation using Hamiltonian method – Linear Quadratic regulator

Text Books:

1. Modern Control System Theory by M.Gopal – New Age International -1984
2. Control System Engineering, Nagrath and Gopal - New Age International – Fourth Edition

References:

1. Optimal control by Kirck , Dover Publications
2. Advanced Control Theory A. Nagoor Kani, RBA Publications, 1999
3. Modern Control Engineering by Ogata.K – Prentice Hall - 1997

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I Year – II Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**0**	**3**

Elective-III and IV

(PSS21) POWER QUALITY

Prerequisites: Analysis of power electronic converters, Power systems

Course Objectives:

- Definition of power quality and different terms of power quality.
- Study of voltage power quality issue - short and long interruption
- Detail study of characterization of voltage sag magnitude and three phase unbalanced voltage sag.
- Know the behavior of power electronics loads; induction motors, synchronous motor etc by the power quality issues
- Overview of mitigation of power quality issues by the VSI converters.

Course Outcomes:

- Know the severity of power quality problems in distribution system;
- Understand the concept of voltage sag transformation from up-stream (higher voltages) to down-stream (lower voltage);
- Concept of improving the power quality to sensitive load by various mitigating custom power devices;

UNIT I:

Introduction: Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring

UNIT II:

Long Interruptions: Interruptions – Definition – Difference between failure, outage, Interruptions – causes of Long Interruptions – Origin of Interruptions – Limits for the Interruption frequency – Limits for the interruption duration – costs of Interruption – Overview of Reliability evaluation to power quality, comparison of observations and reliability evaluation.

Short Interruptions: Short interruptions – definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.

UNIT III:

Voltage sag – Characterization – Single Phase: Voltage sag – definition, causes of voltage sag, voltage sag magnitude,monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems, voltage sag duration.

Voltage sag – characterization – Three Phase: Three phase faults, phase angle jumps, magnitude and phase angle jumps forthree phase unbalanced sags, load influence on voltage sags.

UNIT IV:

PQ Considerations in Industrial Power Systems: Voltage sag – equipment behaviour of Power electronic loads, induction motors, synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives. Harmonics, Harmonics indices, Inter harmonics, Notching – Voltage vs Current distortion – Harmonics vs Transients – Sources and effects of harmonic distortion – System response characteristics – Principles of controlling harmonics – Standards and limitation – Mitigation and control techniques.

UNIT V:

Mitigation of Interruptions and Voltage Sags: Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault learing time changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller.

Power Quality and EMC Standards: Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards, PQ surveys.

References:

1. "Understanding Power Quality Problems" by Math H J Bollen. IEEE Press.
2. Roger C. Durgan, Mark F. McGranaghan and H.Wayne Beaty, "Electrical Power Systems Quality", Tatat McGraw-Hill, 2nd Edition, New York, 2008
3. Sankaran.C, "Power Quality", CRC Press, Washington D.C., 2002.

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I Year – II Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**0**	**3**

Elective-III and IV

(PES21) DIGITAL CONTROL SYSTEMS

Prerequisites : Linear control systems, Z-Transforms

Course Objectives:

- To explain basic and digital control system for the real time analysis and design of control systems.
- To apply the knowledge state variable analysis in the design of discrete systems.
- To explain the concept of stability analysis and design of discrete time systems.

Course Outcomes:

- Illustrate the concepts of Digital control systems.
- Analyse and design discrete systems in state variable analysis.
- Relate the concepts of stability analysis and design of discrete time systems.

UNIT I:

Sampling and Reconstruction: Introduction, sample and hold operations, sampling theorem, Reconstruction of original sampled signal to continuous –time signal.

The Z – Transforms: Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, the inverse Z – transforms, Modified Z- Transforms

Z-Plane Analysis of Discrete-Time Control System: Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems, mapping between s-plane and z-plane: primary strips and complementary strips.

UNIT II:

State Space Analysis: State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations

Controllability and Observability: Concepts of Controllability and Observability, Tests for controllability and Observability. Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function

UNIT III:

Stability Analysis: Stability Analysis of closed loop systems in the Z-Plane. Jury stablility test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion. Stability analysis using Liapunov theorems.

UNIT IV:

Design of Discrete Time Control System by Conventional Methods: Design based on the frequency response method – Bilinear Transformation and Design procedure in the w-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers. Design digital control through deadbeat response method.

UNIT V:

State Feedback Controllers and Observers: Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula.

State Observers – Full order and Reduced order observers.
Linear Quadratic Regulators: Min/Max principle **,**Linear Quadratic Regulators, Kalman, state estimation through Kalman filter, Introduction to adaptive controls.

Text Books:
1. Discrete-Time Control systems - K. Ogata, Pearson Education/PHI, 2nd Edition
2. Digital Control and State Variable Methods by M.Gopal, TMH, Third Edition

References:
1. Digital Control Systems, Kuo, Oxford University Press, 2ndEdition, 2003.
2. Digital Control Engineering, M.Gopal, New Age International Publishers, 2003
3. Control Systems Engineering, I.J. Nagrath and Gopal, Prentice Hall, 3rd Edition.

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I Year – II Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**0**	**3**

Elective-III and IV

(PES22) EMBEDDED SYSTEMS

Prerequisites: Microprocessors and Interfacing Devices

Course Objectives:

- To Comprehend the general embedded system concepts , design of embedded hardware and software development tools
- To explain the basics of real time operating and embedded systems
- To Describe key issues such as CPU scheduling, memory management, task synchronization, and
  file system in the context of real-time embedded systems.

Course Outcomes:

- Analyze and design embedded systems and real time systems
- Define the unique design problems and challenges of real time systems
- Identify the unique characteristics of real time operating systems and evaluate the need for real time operating system
- Explain the general structure of a real time system and understand and use RTOS to build an embedded real time system
- Gain knowledge and skills necessary to design and develop embedded applications based on real time operating systems

UNIT I:

An Introduction to Embedded Systems: An Embedded system, processor in the system, other hardware units, software embedded into a system, exemplary embedded systems, embedded system – on – chip (SOC) and in VLSI circuit. Processor and memory organization – Structural units in a Processor, Processor selection for an embedded system, memory devices, memory selection for an embedded systems, allocation of memory to program cache and memory management links, segments and blocks and memory map of a system, DMA, interfacing processors, memories and Input Output Devices.

UNIT II:

Devices and Buses for Device Networks: I/O devices, timer and counting devices, serial communication using the "I2 C" CAN, profibus foundation field bus. and advanced I/O buses between the network multiple devices, host systems or computer parallel communication between the networked I/O multiple devices using the ISA, PCI, PCI-X and advanced buses.

UNIT III:

Device Drivers and Interrupts Servicing Mechanism: Device drivers, parallel port and serial port device drivers in a system, device drivers for internal programmable timing devices, interrupt servicing mechanism

UNIT IV:

Programming Concepts and Embedded Programming in C, C++, VC++ and Java: Inter process communication and synchronization of processes, task and threads, multiple processes in an application, problem of sharing data by multiple tasks and routines, inter process communication.

UNIT V:

Hardware: Software co-design in an embedded system, embedded system project management, embedded system design and co-design issues in system development process, design cycle in the development phase for an embedded system, use of target systems, use of software tools for development of an embedded system, use of scopes and logic analysis for system, hardware tests. Issues in embedded system design.

Text Books:

1. Embedded systems: Architecture, programming and design by Rajkamal, TMH
2. Embedded system design by Arnold S Burger, CMP

References:

1. An embedded software primer by David Simon, PEA
2. Embedded systems design:Real world design be Steve Heath; Butterworth Heinenann, Newton mass USA 2002
3. Data communication by Hayt.

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I Year – II Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**0**	**3**

Elective-III and IV

(PES23) RELIABILITY ENGINEERING

Prerequisites: Mathematics, Power Systems-I & II, Distribution systems, Power System Protection.

Course Objectives:

- Understand the concepts of Reliability and Unreliability
- Derive the expressions for Probability of failure, Expected value and standard deviation of Binominal distribution, Poisson distribution, normal distribution and weibull distributions.
- Formulating expressions for Reliability analysis of series-parallel and Non-series parallel systems
- Deriving expressions for Time dependent and Limiting State Probabilities using Markov models.

Course Outcomes:

- Apply fundamental knowledge of Reliability to modeling and analysis of series-parallel and Non-series parallel systems.
- Solve some practical problems related with Generation, Transmission and Utilization of Electrical Energy.
- Understand or become aware of various failures, causes of failures and remedies for failures in practical systems.

UNIT I:

Rules for combining probabilities of events, Definition of Reliability. Significance of the terms appearing in the definition.

Probability Distributions: Random variables, probability density and distribution functions. Mathematical expectation, Binominal distribution, Poisson distribution, normal distribution, weibull distribution.

UNIT II:

Hazard rate, derivation of the reliability function in terms of the hazard rate.

Failures: Causes of failures, types of failures (early failures, chance failures and wear-out failures). Bath tub curve. Preventive and corrective maintenance. Modes of failure.

Measures of Reliability: mean time to failure and mean time between failures.

UNIT III:

Classification of Engineering Systems: Series, parallel and series-parallel systems-Expressions for the reliability of the basic configurations.

Reliability Evaluation of Non-Series-Parallel Configurations: Decomposition, Path based and cutest based methods, Deduction of the Paths and cutsets from Event tree.

UNIT IV:

Discrete Markov Chains: General modelling concepts, stochastic transitional probability matrix, time dependent probability evaluation and limiting state probability evaluation of one component repairable model. Absorbing states.

Continuous Markov Processes: Modelling concepts, State space diagrams, Stochastic Transitional Probability Matrix, Evaluating time dependent and limiting state Probabilities of one component repairable model. Evaluation of Limiting state probabilities of two component repairable model.

UNIT V:

Approximate system Reliability analysis of Series systems, parallel systems with two and more than two components, Network reduction techniques. Minimal cutest/failure mode approach.

Text Books:

1. "Reliability evaluation of Engineering systems Concepts and Techniques, Roy Billinton and Ronald N Allan, second edition .BS Publications.
2. "Reliability Engineering", Elsayed A. Elsayed, Wiley Publications, Second Edition.

References:

1. "Reliability Engineering: Theory and Practice", By Alessandro Birolini, Springer Publications.
2. "An Introduction to Reliability and Maintainability Engineering", Charles Ebeling, TMH Publications.
3. "Reliability Engineering", E. Balaguruswamy, TMH Publications.

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I Year – II sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**0**	**3**

Elective-III and IV

(PES25) FACTS Controllers

Prerequisites: Power Electronics, Power Systems, Reactive power control

Course Objectives:

- Students should Comprehend the fundamentals of FACTS Controllers, Importance of controllable parameters and types of FACTS controllers & their benefits
- To outline Objectives of Shunt and Series compensation
- To relate to the Control of STATCOM and SVC and their comparison And the regulation of STATCOM
- To explain Functioning and control of GCSC, TSSC and TCSC

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Analyze the Power and control circuits of Series Controllers GCSC, TSSC and TCSC.
- Select proper controller for the specific application based on the system requirements.
- Comprehend various systems thoroughly and their requirements
- Understand the control circuits of Shunt Controllers SVC & STATCOM for various functions viz. Transient stability
- Enhancement, voltage instability prevention and power oscillation damping.

UNIT I:

Facts Concepts: Transmission interconnections power flow in an AC system- loading capability limits- Dynamic stability considerations- importance of controllable parameters basic types of FACTS controllers- benefits from FACTS controllers, Requirements and Characteristics of High Power devices- Voltage and Current rating, Losses and speed of switching, parameter trade-off of devices.

UNIT II:

Voltage Source Converters: Single phase three phase full wave bridge converters transformer connections for 12 pulse 24 and 48 pulse operation- Three level voltage source converter-pulse width modulation converter, basic concept of current source Converters- comparison of current source converters with voltage source converters.

UNIT III:

Static Shunt Compensation: Objectives of shunt compensation- midpoint voltage regulation voltage instability prevention- improvement of transient stability- Power oscillation damping- Methods of controllable Var generation- variable impedance type static Var generators switching converter type Var generators hybrid Var generators.

UNIT IV:

SVC and STATCOM: The regulation and slope transfer function and dynamic performance- transient stability enhancement and power oscillation damping - operating point control - summary of compensator control.

UNIT V:

Static Series Compensators: Concept of series capacitive compensation- improvement of transient stability- power oscillation damping-Functional requirements- GTO thyristor controlled series capacitor (GSC) - thyristor switched series capacitor (TSSC)-Thyristor Controlled Series Capacitor(TCSC) - control schemes for GSC, TSSC and TCSC.

Text Books:

1. N.G. Hingorani and L. Guygi, "Understanding FACTS Devices" IEEE Press Publications 2000.
2. Padiyar, K. R. "FACTS Controllers in Power Transmission and Distribution" New Age International Publications, 2007.

References:

1. Enrique Acha, "FACTS: modelling and simulation in power networks", Wiley Publishers.
2. Hug song, "Flexible AC transmission system", Wiley and Interline Publishers.
3. Bikash Pal, "Flexible AC transmission system: Modelling and control", Springer Publishers.
4. Zhang, Xiao – Ping, Rehtanz, Christian, Pal, Bikash "FlexibleAC Transmission Systems: Modelling and Control", Singer, 2012.
5. Yong – Hua Sng, Allan Johns, "Flexible AC Transmission Systems", IET, 1999.

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I Year – II Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**0**	**3**

Elective-III and IV

(PES24) ANALYSIS AND DESIGN OF SWITCHED MODE CONVERTERS

Prerequisites: Power Electronics, Electronic devices and circuits

Course Objectives:

- To get awareness on various modes of operation of DC-DC Converter
- To get awareness on control aspects of converter
- To get awareness on design aspects of converter
- To get awareness on Heat sink calculations

Course Outcomes :

Upon the completion of this subject, the student will be able

- To analyze various modes of operation of Dc-Dc converter
- To design simulate control topologies for converter
- To design various components of dc-dc converter
- To analyze dc-dc converter in thermal point of view.

UNIT I:

DC-DC Switched Mode Converters: Review of Buck Converter, Boost Converter, Buck, Boost, CUK & SEPIC converter, Duty cycle derivation, Different conduction modes (CCM & DCM), Voltage and Current waveforms, Calculation of output voltage ripple, Problems.

UNIT II:

Switching DC Power Supplies: Linear power supplies, Overview of switching power supplies, switching losses, Fly back and Forward Converters. Duty cycle derivation, waveforms, comparison of converters, Problems

UNIT III:

Control Aspects: Voltage feed- forward PWM control, Current mode control, Power Supply Protection, Electrical isolation in the feedback loop, Designing to meet Power Supply Specifications

UNIT IV:

Converter Design (for Buck, Boost, Flyback & Forward Converters only): Selection of output filter capacitor, Selection of energy storage inductor, Design of High Frequency Inductor and High frequency Transformer, Selection of switches. Snubber circuit design, Pulse width modulator circuit, Design of driver circuits, Necessity of EMI filter

UNIT V:

Thermal Model: Thermal Resistance, Selection of Heat sinks, Simple Heat sink calculations
Applications: DC/DC converter as Power Factor Corrector (active shaping of the line current) Offline Computer Power Supply System, Uninterruptible AC Power Supplies, Space Craft Power Supply etc

Text Books:

1. Mohan N. Undeland . T & Robbins W., Power Electronics Converters, Application and Design. John Wiley, 3rd edition, 2002
2. Umanand L., Bhat S.R., Design of magnetic components for switched Mode Power Converters. , Wiley Eastern Ltd.,1992
3. Robert. W. Erickson, D. Maksimovic .Fundamentals of Power Electronics., Springer International Edition, 2005
4. Course Material on Switched Mode Power Conversion, V. Ramanarayanan.

References:

1. Krein P.T .Elements of Power Electronics., Oxford University Press
2. M.H.Rashid, Power Electronics. Prentice-Hall of India

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I Year – II sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**0**	**3**

Open Elective-II

(PES41) RENEWABLE POWER GENERATION TECHNOLOGIES

Course Objectives:

- To recognize the awareness of energy conservation in students
- To identify the use of renewable energy sources for electrical power generation
- To collect different energy storage methods
- To detect about environmental effects of energy conversion

Course Outcomes:

Upon the completion of the subject, the student will be able to

- Find different renewable energy sources to produce electrical power
- estimate the use of conventional energy sources to produce electrical energy
- role-play the fact that the conventional energy resources are depleted
- arrange Store energy and to avoid the environmental pollution

UNIT I:

Photo Voltaic Power Generation: Photo voltaic power generation ,spectral distribution of energy in solar radiation, solar cell configurations, voltage developed by solar cell, photo current and load current, practical solar cell performance, commercial photo voltaic systems, test specifications for PV systems, applications of super conducting materials in electrical equipment systems.

UNIT II:

MHD Power Generation and Wind Energy: Principles of MHD power generation, ideal MHD generator performance, practical MHD generator, MHD technology.

Wind Energy Conversion: Power from wind, properties of air and wind, types of wind Turbines, operating characteristics.

UNIT III:

Tidal Power and Wave Energy: Tides and tidal power stations, modes of operation, tidal project examples, turbines and generators for tidal power generation.

Wave Energy Conversion: properties of waves and power content, vertex motion of Waves, device applications. Types of ocean thermal energy conversion systems Application of OTEC systems examples,

UNIT IV:

Storage Systems: Energy Storage Parameters – Lead–Acid Batteries – Ultra capacitors – Flywheels – superconducting Magnetic Storage System – Pumped Hydroelectric Energy Storage – Compressed Air Energy Storage –Storage Heat –Energy Storage as an Economic Resource

UNIT V:

Fuel Cells: Types of fuel cells, H_2-O_2 Fuel cells, Application of fuel cells – Batteries, Description of batteries, Battery application for large power. Environmental effects of energy conversion systems, pollution from coal and preventive measures steam stations and pollution, pollution free energy systems.

Text Books:

1. "Energy conversion systems" by Rakosh das Begamudre, New age International publishers, New Delhi - 2000.
2. "Renewable Energy Resources" by John Twidell and Tony Weir, 2nd Edition, Fspon & Co.

References:

1. "Understanding Renewable Energy Systems" by Volker Quaschning, 2005, UK.
2. "Renewable Energy Systems-Advanced Conversion, Technologies & Applications" by Faner Lin Luo Honer Ye, CRC press, Taylor & Francies group.
3. Felix A. Farret, M. GodoySimoes,Integration of Alternative Sources of Energy, John Wiley & Sons, 2006.
4. Remus Teodorescu, Marco Liserre, Pedro Rodríguez,Grid Converters for Photovoltaic and Wind Power Systems,John Wiley & Sons, 2011.
5. Gilbert M. Masters, Renewable and Efficient Electric Power Systems, John Wiley & Sons

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I Year – II Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	3	**0**	**3**

Open Elective-II

(PES42) PROGRAMMABLE LOGIC CONTROLLERS AND THEIR APPLICATIONS

Prerequisite: None

Course Objectives:

- It is to provide and ensure a comprehensive understanding of using advanced controllers in measurement and control instrumentation.
- To illustrate about data acquisition - process of collecting information from field instruments.
- To analyze Programmable Logic Controller (PLC), IO Modules and internal features.
- To Comprehend Programming in Ladder Logic, addressing of IO.
- To apply PID and its Tunning.

Course Outcomes:

- Describe the main functional units in a PLC and be able to explain how they interact.
- Know different bus types used in automation industries.
- Develop ladder logic programming for simple processes.

UNIT I:

PLC Basics: PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

UNIT II:

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation.

Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams for process control: Ladder diagrams & sequence listings, ladder diagram construction and flow chart for spray process system.

UNIT III:

PLC Registers: Characteristics of Registers, module addressing, holding registers, input registers, output registers.

PLC Functions: Timer functions & Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

UNIT IV:

Data Handling functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR & Sweep functions and their applications.

Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axis & three axis Robots with PLC, Matrix functions.

UNIT V:

Analog PLC Operation: Analog modules & systems, Analog signal processing, multi bit data processing, analog output application examples, PID principles, position indicator with PID control, PID modules, PID tuning, PID functions.

Text Books:

1. Programmable Logic Controllers – Principle and Applications by John W. Webb & Ronald A. Reiss, Fifth Edition, PHI
2. Digital Design by Morris Mano, PHI, 3rd Edition 2006.

References:

1. Programmable logic Controllers, Frank D. Petruzella, 4th Edition, McGraw Hill Publishers.
2. Programmable Logic Controllers – Programming Method and Applications by JR. Hackworth & F.D Hackworth Jr. – Pearson, 2004.
3. Programmable logic controllers and their Engineering Applications, 2nd Edition, Alan J. Crispin.

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	3	**0**	**3**

Open Elective I

(PSS41) OPTIMIZATION TECHNIQUES

Prerequisite: None

Course Objectives:

- To understand linear programming
- To understand optimization problem statement.
- To understand single variable and multi variable optimization problems with equality and inequality
  constraints
- To understand various optimization techniques.

Course Outcomes:

Students will be able to:

- Formulate mathematical statement of optimization problem
- Understand various methods of optimization techniques
- Understand the concept of genetic algorithm

UNIT I:

Introduction and Classical Optimization Techniques: Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.

Classical Optimization Techniques: Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints.

Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

UNIT II:

Linear Programming: Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm.

Transportation Problem:

Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems.

UNIT III:

Unconstrained Nonlinear Programming: One – dimensional minimization methods: Classification, Fibonacci method and Quadratic interpolation method

Unconstrained Optimization Techniques: Univariate method, Powell's method and steepest descent method.

UNIT IV:

Constrained Nonlinear Programming: Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method; Basic approaches of Interior and Exterior penalty function methods. Introduction to convex Programming Problem.

UNIT V:

Dynamic Programming: Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

Text Books:

1. Engineering optimization: Theory and practice by S. S.Rao, New Age International (P) Limited, 3rd edition, 1998.
2. Introductory Operations Research by H.S. Kasene and K.D. Kumar, Springer (India), Pvt .Ltd.

References:

1. Optimization Methods in Operations Research and systems Analysis – by K.V. Mital and C. Mohan, New Age International (P) Limited, Publishers, 3rd edition, 1996.
2. Operations Research – theory and applications by Dr. S.D.Sharma, Macmillan publishers India Ltd, 4th edition.
3. Operations Research: An Introduction" by H.A. Taha, PHI Pvt. Ltd, 6th edition.
4. Linear Programming by G. Hadley, A. W. Pub.Company, 1962.

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I Year – II Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	0	**3**	**2**

(PES52) POWER CONVERTERS AND DRIVES LAB

Pre-requisites: All core subjects

Course Objectives:

- Show awareness of the impact of power electronic control circuits on utility supply
- To observe the difference of the conventional and power electronic control of drives.
- Have a better understanding of the close relationship between hardware and simulation models of actual systems.
- To familiarize the student with various power electronic converter topologies and their speed
- Control application (open loop and closed loop operation)

Course Outcomes:

Student will be able to

1. Conduct experiments on drives for different modes of operation using different converter topologies.
2. Select the suitable controller for getting the desired speed performance of drive.
3. Validate the results

LIST OF EXPERIMENTS

1. Speed Measurement and closed loop control using PMDC motor.
2. Thyristorised drive for PMDC Motor with speed measurement and closed Loop control.
3. IGBT used single 4 quadrant chopper drive for PMDC motor with speed measurement and closed loop control.
4. Thyristorised drive for 1Hp DC motor with closed loop control.
5. 3-Phase input, thyristorised drive, 3 Hp DC motor with closed loop
6. 3-Phase input IGBT, 4 quadrant chopper drive for DC motor with closed Loop control equipment.
7. Cyclo-converter based AC Induction motor control equipment.
8. Speed control of 3 phase wound rotor Induction motor.
9. Single-phase fully controlled converter with inductive load.
10. Single phase half wave controlled converter with inductive load.
11. Isolated Gate Drive circuits for MOSFET / IGBT based circuits.
12. Characteristics of solar PV Systems.
13. Maximum Power Point Tracking Charge Controllers.
14. Inverter control for Solar PV based systems.

Note: Any ten experiments can be conducted.

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I Year – II sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	0	**6**	**4**

(PES62) MINI PROJECT-II

Course Objectives:

- To improve the capability of surveying for required literature.
- To inculcate the design ability of electrical systems
- To enhance the skills of fabricating the hardware projects
- To correlate the experimental results with theoretical/designed data.

Course Outcomes:

- Carry out Literature study and give problem statement
- Select Control Strategy, design methodology and develop a suitable model for the chosen problem
- Execute and validate the Model
- Communicate effectively
- Write a technical report

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II Year – I Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	0	**0**	**4**

(PES63) COMPREHENSIVE VIVA-VOCE

Course Objectives:

- To get a global and overall view on the subject.
- To refresh the technical content at finishing stage of the program.
- To enhance the communication and presentation skills.

Course Outcomes:

- Comprehend the fundamentals and technical knowledge in power electronics and its allied fields.
- Apply and analyze power electronics concepts in its allied fields
- Communicate effectively

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II Year – I Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	0	**0**	**8**

(PES71) INTERNSHIP/DISSERTATION PHASE – I

Course Objectives:

- To improve the capability of surveying for required literature.
- To inculcate the design ability of electrical systems
- To enhance the skills of fabricating the hardware projects
- To correlate the experimental results with theoretical/designed data.

Course Outcomes:

- Carry out Literature study and give problem statement
- Select Control Strategy, design methodology and develop a suitable model for the chosen problem
- Execute and validate the Model
- Communicate effectively
- Write a technical report

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II Year – II Sem M.Tech (Power Electronics)	**L**	**T/P/D**	**C**
	0	**0**	**18**

(PES72) DISSERTATION PHASE – II

Course Objectives:

- To improve the capability of surveying for required literature.
- To inculcate the design ability of electrical systems
- To enhance the skills of fabricating the hardware projects
- To correlate the experimental results with theoretical/designed data.

Course Outcomes:

- Carry out Literature study and give problem statement
- Select Control Strategy, design methodology and develop a suitable model for the chosen problem
- Execute and validate the Model
- Communicate effectively
- Write a technical report